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## Author Affiliation:

<sup>1</sup>Family Medicine Resident, Almadinah Almunawara, Saudi Arabia;  
Email: majedalharbi132@gmail.com

<sup>2</sup>Family Medicine Consultant, Almadinah Almunawara, Saudi Arabia

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# Knowledge attitude and practice among primary health care physicians toward diabetic retinopathy in Almadinah Almunawara, Saudi Arabia in 2020

Majed Mosad Alharbi<sup>1</sup>, Khaled Saad Alghamdi<sup>2</sup>

## ABSTRACT

**Objectives:** To assess the knowledge, attitude and practice of primary health care physician toward diabetic retinopathy in Almadinah in 2020. **Materials and methods:** This is a descriptive cross-sectional study carried out in Almadinah Almunawara city on December, 2020 included a random sample of the Ministry of Health- primary health care physicians. **Results:** The study included 155 primary healthcare physicians. Almost one-third of them (36.1%) had special training on diabetes management. Majority of them (98.1%) followed any guideline for care of diabetes in practice; American Diabetic association and Saudi guidelines were followed by 69.7% and 53.9% of physicians, respectively. The total DR knowledge score ranged between 7 and 14 (out of a possible maximum of 14). Family physician had the highest score of knowledge about DR (mean rank was 90.87). Physicians who reported having special training on diabetes management expressed better knowledge about DR than others. The attitude towards DR score ranged between 14 and 28. The practice of DR score ranged between 17 and 48. Physicians who reported >40% of their seen patients were diabetics had the highest practice related to DR score (mean rank = 95). **Conclusion:** Knowledge and attitude of physicians working at primary healthcare centers, Ministry of Health in Almadinah Almunawara regarding DR is overall accepted. However, their practice-related to diabetic retinopathy is deficient in some important aspects.

**Keywords:** Diabetic retinopathy, knowledge, Attitude, Practice, Primary care physicians

## 1. INTRODUCTION

Diabetes mellitus (DM) is a common health problem in Saudi Arabia and other countries of Middle East (Khandekar, 2012). It is the second highest rate of diabetes in the Middle East and 7th highest internationally according to the



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world health organization (Al Dawish et al., 2016; Elhadd et al., 2007). It is estimated to be increased, diabetic individuals will increased by 2 times in 2025 (Wild et al., 2004; IDF, 2015). A community based surveys show the prevalence of DM among adults was 21.2% (Shay et al., 2016; Bahijri et al., 2016). It showed that the prevalence of DM and prediabetes among adults >50 years was 37.4% and 15.4%, respectively which was very close to our previously reported prevalence of DM 29.7% (Al Ghamdi et al., 2012). According to a local study done between the year 2004 and 2011, prevalence of diabetes mellitus in Saudi Arabia increased from 23.7% to 34.1% (El-Bab et al., 2012).

Diabetic retinopathy (DR) is caused by diabetes mellitus and is one of the main causes of vision lose among people (Robert et al., 2017). Diabetic retinopathy decrease quality of life. It is slowly progressive microangiopathy of retinal capillaries leading to destruction of retina which lead finally to blindness (Zhang et al., 2010). The prevalence of chronic eye disease like diabetic retinopathy worldwide necessitate to establish appropriate prevention programs nationally to cope with long term bad consequences of such these eye disease. Untreated retinopathy leads to personal and social problems which are reflected nationally on increasing burden on overall economy of the nation (Sparrow et al., 1993).

In Saudi Arabia, diabetes costs 13.9% of total healthcare expenditure. Expenses on diabetes were increased by five times. In the past, (2014) it cost 25 billion riyal out of total healthcare budget -180 billion Riyals (Alhowaish et al., 2013). An international review of Diabetic retinopathy reported that an average of 34.6% of all diabetic patients have variable forms of DR (Raman et al., 2009). According to local study done in Al-hassa region, diabetic retinopathy responsible about 29% of blindness among Saudi diabetics and is considered to be sight threatening for another 20% of Saudi diabetics (Khan et al., 2010). Another study done in southern Saudi Arabia showed prevalence of DR among type 2 diabetic Saudi patients was 36.4%. The prevalence of the severe non-proliferative DR was 11% and proliferative retinopathy 11.6%. 7.2% of patients had maculopathy. The application of the standardized rapid assessment (RAAB) of avoidable blindness and the cross-DR methodology in the two recombinations of Saudi Arabia showed that the prevalence of bilateral blindness was between 2.6% and 3.3% (Hajar et al., 2015). It is highly necessary to establish a comprehensive disease management program / interdisciplinary approach in which general practitioners play an important role. Early screening and detection of DR at the primary health care level is important to prevent blinded complications of end-stage DR (Ahmed et al., 2016; El-Asrar et al., 1998).

The first study was done in Taif as 180 general practitioners (GPs) were involved in this study. Majority of Participants (97.2%) had good knowledge and attitude toward screening for DR. About prevalence of DM in Saudi, (92.8%) of them know the importance of early detection of DR to prevent complications, 43.9% of participants lack enough skills in fundus examination. Finally it recommends improving screening facilities at the level of primary health care system in Saudi Arabia (Al Ghamdi et al., 2017). Another study was done in Riyadh among 216 primary health care physician participate. A substantial variance in knowledge between physicians who had training in family medicine specialty compared to others. There was a defect in screening and follow-up of type1 DM patients (Al Rasheed et al., 2017). At the level of Arab gulf countries I found a study done among North Sharqiya region of Oman physicians. It included 40 responded physicians; 58% of participants had good knowledge of different parts of eye and 40 % of them had good knowledge about methods of fundus examination (Khandekar et al., 2008).

Internationally, one study was done in India showed the need for good training of GPs about DR and how to detect it with direct ophthalmoscope. Lack of dilating drops, and lack of knowledge of the guidelines among GPs were reported. The authors recommended providing appropriate ophthalmoscopy training during residency programs (Raman et al., 2006). In Canada, a study was done to assess knowledge of family physician regarding Canadian guidelines. The study included 1038 GPs and 125 family medicine residents participate with a response rate of 62% and 77%, respectively. Most of the respondents (80%) correctly chose statement with the current guidelines for first screening of DR shortly after diagnosis in type 2 DM patients, and 13% knew the right time for DR screening among type 1 DM patients. Most of participant lack adequate skills in fundus examination (Delorme et al., 1998).

Last study involved in this review was done among physicians in Northwestern Nigeria. 105 physicians participate in this study. 78.8% of them were aware of effective methods of delaying onset of DR. 94.1% of them know the frequency of eye examination. Lack of ophthalmoscope and dilating drugs form important were the main barriers to do eye examination. Finally the study concluded that DR screening skills among physicians in northwestern Nigeria was suboptimal and they recommend improving training programs of physicians (Abdulsalam et al., 2018).

## Study objectives

### General objectives

To assess the knowledge, attitude and practice of primary health care (PHC) physician toward diabetic retinopathy in Almadinah in 2020.

**Specific objectives**

- To measure the level of knowledge of PHC physicians on diabetic retinopathy in Almadinah in 2020
- To find out the attitude of PHC physicians on diabetic retinopathy in Almadinah in 2020
- To assess the practice of PHC physicians on diabetic retinopathy in Almadinah in 2020
- To compare the practice of physicians who had training in family medicine programs with other PHC physicians.
- To determine factors associated with knowledge.
- To determine factors associated with attitude.
- To determine factors associated with practice.

**2. METHODOLOGY****Study design, area and duration**

This is a descriptive cross-sectional study. The study was carried out during the period from December 1, 2019 to December 31, 2020, at Almadinah Almunawara city, located in western area in Saudi Arabia. It has about 1 million citizens. It is considered one of the main cities in Saudi Arabia and one of holy places for Muslims beside Makah holy mosque located in Almadinah and it contains many places and mosques of religious and historical importance. Nowadays it connected to the world through Prince Mohammed bin Abdul-Aziz through international airport and to main cities in Saudi Arabia like Jeddah, Makkah and Riyadh through a network of roads.

**Population**

This study was conducted at the Ministry of Health PHCs in Almadina. It included both male and female family physicians and general practitioners who work in the MOH primary health care centers.

**Exclusion criteria**

Dentists

**Study tool**

Responses were got via a semi-structured multi-point questionnaire that was previously prepared in English. It is composed of closed-ended questions that were set out in a Likert's scale. Individual knowledge items in the scale had three response alternatives (yes, no, don't know). While attitude items had five response alternatives: Arranged from strongly agree to strongly disagree. The highest score (5) in this scale, meant a favorable response while lowest score, (1) indicated a least favorable response. The final questionnaire was arranged in four sections. Section (1) contained demographic data and general questions about the respondents; it did not include personal details of the respondent. Section (2) contained 14 questions on knowledge and awareness levels. Section (3) contained 12 questions about the practices toward screening DR. Section (4) contained questions on attitudes toward DR (Al Ghamdi et al., 2017).

**Sampling techniques**

Random multistage sampling was used for this study. The study area was divided into 4 sectors "East, North, West and south". Each sector has 13 centers. Each center has 5 working physician. Total number of PHC physicians in Madinah is 269 physicians. From each sector 40 physician were included. The contributors were carefully chosen randomly.

**Sample size**

Sample size was calculated using OpenEpi, Version 3, open source calculator—SS Propor.

Sample size  $n = [DEFF * Np(1-p)] / [(d^2 / Z^2 * 1 - \alpha / 2 * (N-1) + p * (1-p))]$  Where  $n$  = sample size.

Population size (for finite population correction factor or  $fpc$ )( $N$ ): 269

Hypothesized % frequency of outcome factor in the population ( $p$ ): 50% +/- 5

Confidence limits as % of 100(absolute +/- %) ( $d$ ): 5%

Design effect (for cluster surveys-DEFF):  $n=159$  participants at 95% confidence interval.

**Data analysis**

Collected data were manipulated, cleaned and analyzed via SPSS software; version 25. Categorical data were described using frequency and percentage whereas numerical data were described using mean and standard deviation for normally distributed variables and median, interquartile range (IQR) for abnormally distributed variables. Non-parametric statistical tests were used for comparisons since the KAP scores were abnormally distributed as shown by significant Shaprio-Wilk test. Mann-Whitney test was applied to compare two groups whereas kruskal-Wallis test was utilized to relate more than two groups. P-value <0.05 was considered statistically significant.

**Ethical consideration**

Ethical approval to conduct the study was obtained from local committee with ethical approval number (IRB 382). All the questionnaires are free from names. Nobody, except the study group, is allowed to look into filled questionnaires before the end of the study and the collected data were kept in safe and private place and used only for study purposes. Every participant has the right to answer or reject the questionnaire without any added pressure on them.

**3. RESULTS**

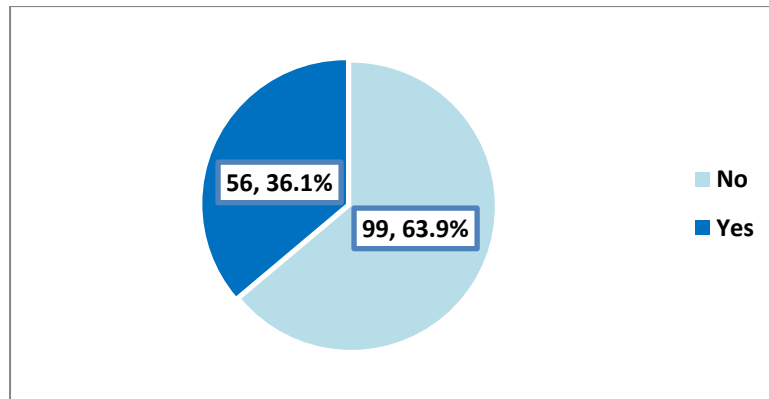
The study included 155 primary healthcare physicians. Females represent 50.3% of them. Their age was available for 135 physicians and ranged between 27 and 64 years (36.8±9.3 years). About half (56.3%) of them were family physicians whereas 27.1% were general practitioners. Postgraduate qualification was reported by most of them (72.3%). Years of practice ranged between 5 and 15 years among 44.5% of the physicians. Regarding percentage of seen diabetic patients, majority of them (74.2%) reported between 10 and 40% (Table 1).

**Table 1** personal characteristic of the primary healthcare physicians, Ministry of Health, Almadinah Almunawara

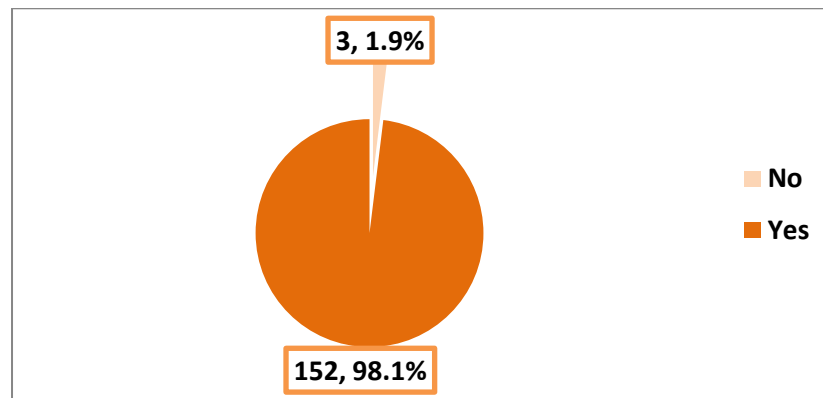
	Frequency	Percentage
Gender		
Male	77	49.7
Female	78	50.3
Age (year) (n=135)		
Range	27-64	
Mean±SD	36.8±9.3	
Specialty		
General practitioner	42	27.1
Family medicine	87	56.1
Internal Medicine	16	10.3
Pediatrics	06	3.9
Others*	04	2.6
Postgraduate qualification		
No	43	27.7
Yes	112	72.3
Years of practice		
<5	52	33.5
5-15	69	44.5
>15	34	22.0
Percentage of seen diabetic patients		
<10%	14	9.0
10-20%	59	38.1
21-40%	56	36.1
>40%	26	16.8

\*Obstetrics and gynecology/Occupational medicine

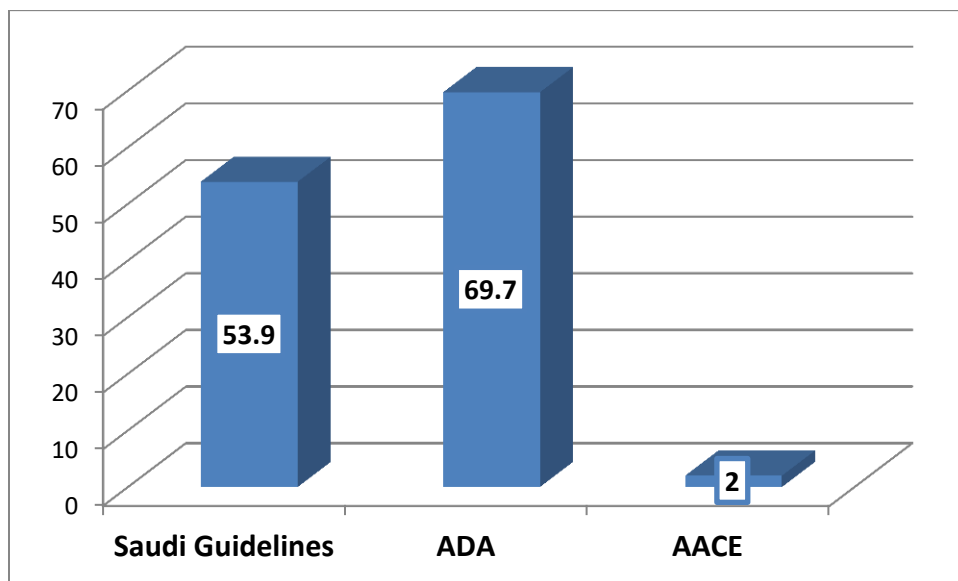
Almost one-third of the participants (36.1%) had training courses about diabetes management as evident from Figure 1. Majority of them (98.1%) followed any guideline for care of diabetes in practice (Figure 2). American Diabetic association and Saudi guidelines were followed by 69.7% and 53.9% of them, respectively as clear from Figure 3.



**Figure 1** History of special training in diabetes management among the participants



**Figure 2** History of following any guideline for care of diabetes in practice among the participants



**Figure 3** Guidelines followed by primary healthcare physicians in Almadinah Almunawara for care of diabetes in practice (n=152)  
-Knowledge about diabetic retinopathy

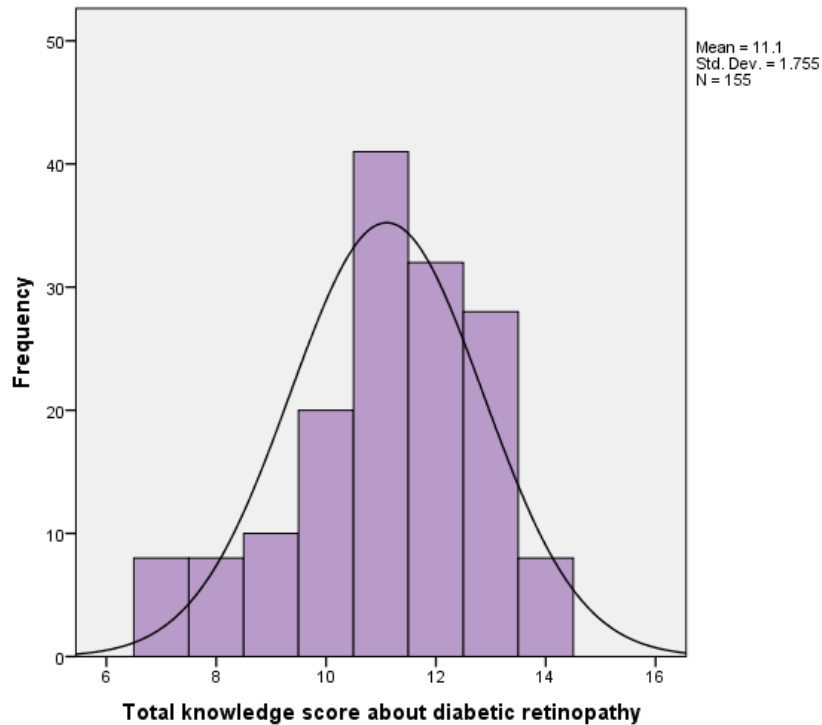
Majority of the physicians knew that KSA has high prevalence of DM (98.7%), a well- structured screening program in the PHC will diminish the visual impact of Diabetic retinopathy (DR) (96.1%), early Diabetic Retinopathy detection and treatment play a critically important role in preventing long term visual loss (94.8%), all diabetic patients should have a periodic retinal (eye)

examination (94.8%), Diabetic Retinopathy is a common cause of severe visual damage in KSA (93.5%), the Glycemic control of Diabetes Mellitus can influence the severity of Diabetic Retinopathy (92.3%) and Ophthalmoscopy and /or Fundus Photography /Imaging is the ideal method to detect diabetic retinopathy (92.3%). On the other hand, less than half of them could recognize that the severity of Diabetic Retinopathy is connected to the period of Diabetes Mellitus (44.5%) and Fluorescein angiography is not essential for the diagnosis and management of all diabetic retinopathies (41.3%).

**Table 2** Responses of the primary healthcare physicians, Ministry of health, Almadinah Almunawara to diabetic retinopathy knowledge statements

Statements	Right response	
	No.	%
KSA has high prevalence of DM. (YES)	153	98.7
Diabetic Retinopathy is a common reason of severe visual deterioration in KSA. (YES)	145	93.5
Diabetics may have advanced diabetic retinopathy inspite of having good vision. (YES)	125	80.6
The severity of Diabetic Retinopathy is not linked to the period of Diabetes Mellitus. (NO)	69	44.5
The Glycemic control of Diabetes Mellitus can influence the severity of Diabetic Retinopathy. (YES)	143	92.3
The serum lipid outline is not linked to the severity of Diabetic Maculopathy. (NO)	110	71.5
Hypertension and renal diseases do not influence the severity of Diabetic Retinopathy. (NO)	134	86.5
Pregnancy can worsen Diabetic Retinopathy. (YES)	83	53.5
Early Diabetic Retinopathy detection and treatment play a critical role in the prevention of permanent visual loss. (YES)	147	94.8
All diabetic patients should have a periodic retinal (eye) examination. (YES)	147	94.8
A well- structured screening program at the setting of the primary health care will reduce the visual impairment due to Diabetic retinopathy (DR). (YES)	149	96.1
Laser Photocoagulation is one of the modalities for treating curative for diabetic retinopathy (YES)	109	70.3
Ophthalmoscopy and /or Fundus Photography /Imaging is the ideal method to detect diabetic retinopathy. (YES)	143	92.3
Fluorescein angiography is not essential for the diagnosis and management of all diabetic retinopathies. (YES)	64	41.3

The total DR knowledge score ranged between 7 and 14 (out of a possible maximum of 14) with a mean of 11.1 and standard deviation (SD) of  $\pm 1.8$  and a median of 11 and IQR of 10-12 (Figure 4).



**Figure 4** Frequency distribution of the total knowledge score about diabetic retinopathy among the participants.

#### Factors affecting with knowledge

Family physician had the highest score of knowledge about DR (mean rank was 90.87), whereas Obstetrics and gynecology/Occupational medicine had the lowest score (mean rank was 54),  $p=0.001$ . Physicians who had postgraduate qualification were more knowledgeable about DR compared to their counterparts (mean ranks were 82.69 and 65.78, respectively),  $p=0.032$ . Physicians who reported having special training on diabetes management expressed better knowledge about DR than others (mean rank was 87.80 versus 72.45,  $p=0.037$ ). Physicians who followed all guidelines (Saudi, ADA and AACE) expressed the highest DR knowledge score (mean rank=102.50) while those followed only the Saudi guideline had the lowest score (44.59),  $p<0.001$  (Table 3).

**Table 3** Factors associated with knowledge of primary healthcare physician's in Almadinah Almunawara about diabetic retinopathy

	Diabetic retinopathy knowledge score			p-value
	Median	IQR	Mean rank	
Gender				
Male (n=77)	11	10-12	79.30	0.715†
Female (n=78)	11	10-13	76.72	
Specialty				
General practitioner (n=42)	11	9-12	64.88	0.001**
Family medicine (n=87)	12	11-13	90.87	
Internal medicine (n=16)	10.5	8.5-12	63.19	
Pediatrics (n=6)	10	8-11	38.67	
Others* (n=4)	9.5	7-12	54.0	
Percentage of seen diabetic patients				
<10% (n=14)	10.43	8-13	65.36	0.311**
10-20% (n=59)	11	10-12	73.58	
21-40% (n=56)	11.21	10-13	80.71	
>40% (n=26)	11.46	10.75-12	89.0	



Postgraduate qualification				
No (n=43)	11	9-12	65.78	
Yes (n=112)	11	11-12.75	82.69	0.032 †
Years of practice				
<5 (n=52)	10.79	10-12	70.54	
5-15 (n=69)	11.23	10.5-12	80.54	
>15 (n=34)	11.32	10-13	84.26	0.300**
Special training in diabetes management				
No (n=99)	10.88	10-13	72.45	
Yes (n=56)	11.5	11-12	87.80	0.037 †
Following any guideline for care of diabetes in practice				
No (n=3)	13	11-14	123.33	
Yes (n=152)	11.07	10-12	77.11	0.072 †
The followed guideline (n=152)				
Saudi (n=46)	9.74	8-11	44.59	
ADA (n=70)	11.54	11-13	87.27	
Both (n=33)	11.82	11-13	95.77	
Both and AACE (n=3)	12	12-12	102.50	<0.001

\* Obstetrics and gynecology/Occupational medicine

† Mann-Whitney test

\*\* Kruskal-Wallis test

### Attitude towards diabetic retinopathy

Majority of the physicians disagreed that eye examination is required in diabetic patients only when vision is affected or not (85.2%), newly detected diabetic patients do require an eye check-up or not (81.3%), diabetic patients require an eye examination by ophthalmologist only at 5 yearly interval or not (78.7%) and primary physician or diabetologists have much role in the prevention and/or treatment of Diabetic retinopathy or not (65.8%). However, majority of them either strongly or moderately agreed that GPs or diabetologists should be actively involved in doing retinal examination as part of Diabetic retinopathy screening program (84.5%), GPs or diabetologists should be periodically retrained in management of Diabetes mellitus (86.4%), all GPs or primary physicians need to have a re-training in eye examination for diabetic retinopathy (88.4%) and a good lipid profile is essential for preventing vision loss in diabetic retinopathy (87.1%) (Table 4).

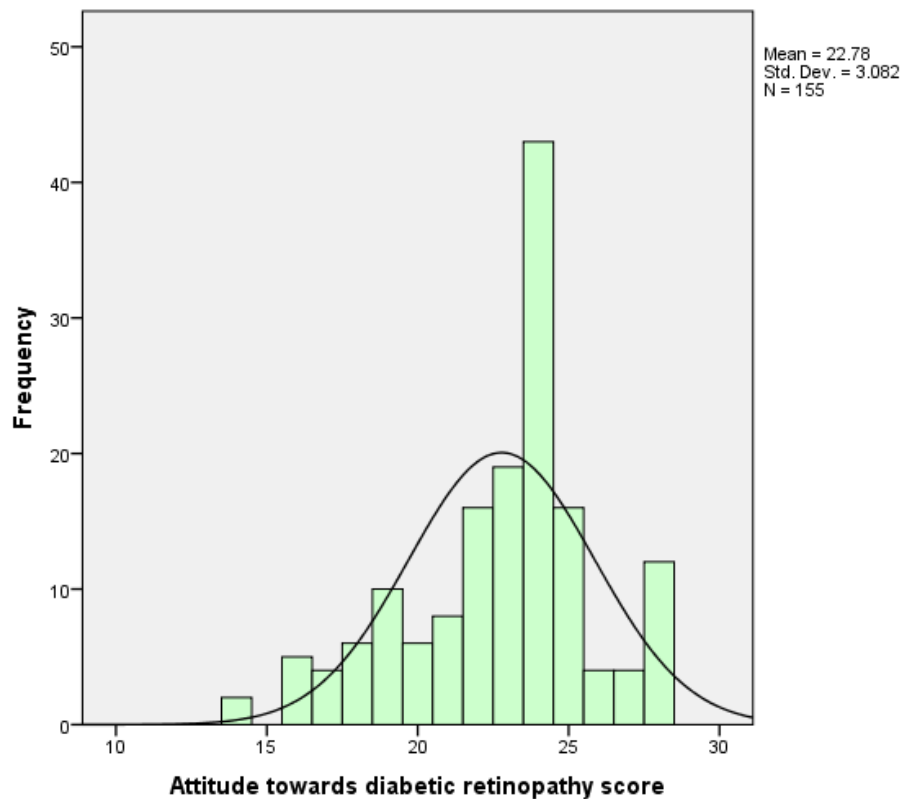
**Table 4** Response of the primary healthcare physicians in Almadinah Almunawara to attitude towards diabetic retinopathy statements

	Strongly agree N (%)	Moderately Agree N (%)	Don't know/ undecided N (%)	Moderately disagree N (%)	Strongly disagree N (%)
Eye Examination is required in diabetic patients only when vision is affected	4 (2.6)	9 (5.8)	0 (0.0)	10 (6.5)	132 (85.2)
Newly detected diabetic patients do not require an eye check-up.	2 (1.3)	9 (5.8)	4 (2.6)	14 (9.0)	126 (81.3)
Diabetic patients require an eye examination by ophthalmologist only at 5 yearly interval	4 (2.6)	9 (5.8)	6 (3.9)	14 (9.0)	122 (78.7)
Primary physician or	14	21	2	16	102



diabetologists have no much role in the prevention and/or treatment of Diabetic retinopathy?	(9.0)	(13.5)	(1.3)	(10.3)	(65.8)
Should GPs or diabetologists be actively involved in doing retinal examination as part of Diabetic retinopathy screening program?	67 (43.2)	64 (41.3)	4 (2.6)	18 (11.6)	2 (4.3)
Should GPs or diabetologists be periodically retrained in management of Diabetes mellitus?	87 (56.1)	50 (32.3)	8 (5.2)	10 (6.5)	0 (0.0)
All GPs or primary physicians need to have a re-training in eye examination for diabetic retinopathy.	93 (60.0)	44 (28.4)	4 (2.6)	12 (7.7)	2 (1.3)
A good lipid profile is essential for preventing vision loss in diabetic retinopathy	88 (56.8)	47 (30.3)	16 (10.3)	4 (2.6)	0 (0.0)

The attitude towards DR score ranged between 14 and 28 (out of a possible maximum of 32) with a mean of 22.8 and standard deviation (SD) of  $\pm 3.1$  and a median of 24 and IQR of 21-24 (Figure 5). Physicians who reported that 21-40% of their seen patients were diabetics had the highest attitude towards DR score (mean rank = 86.89) while those who reported <10% of their seen patients were diabetics had the lowest score (mean rank=48.11),  $p=0.018$  (Table 5).



**Figure 5** Frequency distribution of the total attitude score towards diabetic retinopathy among the participants.

**Table 5** Factors associated with attitude of primary healthcare physician's in Almadinah Almunawara towards diabetic retinopathy

	Diabetic retinopathy attitude score			p-value
	Median	IQR	Mean rank	
Gender				
Male (n=77)	24	19.5-24	75.09	0.417†
Female (n=78)	23	22-25	80.87	
Specialty				
General practitioner (n=42)	24	20-24	75.37	0.599**
Family medicine (n=87)	24	22-24	79.09	
Internal medicine (n=16)	24	21.25-25.75	89.13	
Pediatrics (n=6)	23	20.75-24	67.08	
Others* (n=4)	22	22-22.75	53.88	
Percentage of seen diabetic patients				
<10% (n=14)	21.5	19-23.25	48.11	0.018**
10-20% (n=59)	24	22-24	80.84	
21-40% (n=56)	24	22-25	86.89	
>40% (n=26)	23	19.75-24	68.50	
Postgraduate qualification				
No (n=43)	24	20-24	73.95	0.481†
Yes (n=112)	23.5	22-24.75	79.55	
Years of practice				
<5 (n=52)	23.5	21-24	74.06	0.616**
5-15 (n=69)	24	21-24	78.18	
>15 (n=34)	24	22-25.25	83.66	
Special training in diabetes management				
No (n=99)	24	21-24	78.13	0.961†
Yes (n=56)	24	20.25-24.75	77.77	
Following any guideline for care of diabetes in practice				
No (n=3)	19	14-19	55.17	0.367†
Yes (n=152)	24	21-24	78.45	
The followed guideline (n=152)				
Saudi (n=46)	23	20.75-24	86.76	0.489**
ADA (n=70)	24	22-24.25	81.55	
Both (n=33)	24	20.5-25	76.85	
Both and ACE (n=3)	24	20-24	73.50	

\* Obstetrics and gynecology/Occupational medicine

† Mann-Whitney test

\*\* Kruskal-Wallis test

### Practice related to diabetic retinopathy

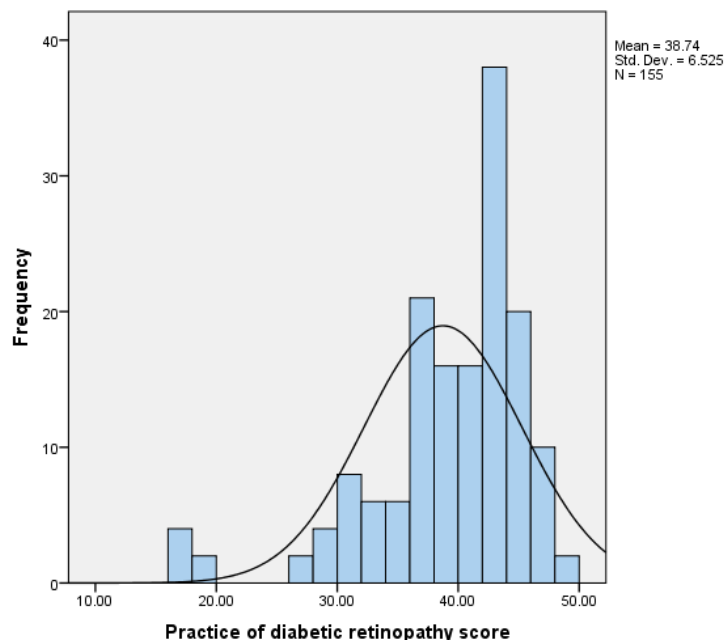
Most of the physicians always check the lipid profile of their diabetic patients regularly (87.7%), check the renal function and blood pressure of their diabetic patients on regular basis (85.1%), check for proteinuria regularly on their diabetic patients (82.6%) and routinely send diabetics to ophthalmologists for an eye evaluation upon the first diagnosis of diabetes (82.6%). On the other hand, 14.2% of them never do ophthalmoscopy routinely to their diabetic patients. Only 47.7% of them always have an ophthalmoscope in their clinic and 45.1% can try doing retinal exam to detect DR using ophthalmoscope, but they are not confident (Table 6).

**Table 6** Response of the primary healthcare physician's in Almadinah Almunawara practice related to diabetic retinopathy statements

	Always Do N (%)	Sometimes do N (%)	Undecided N (%)	Hardly Do N (%)	Never do N (%)
Do you ask your diabetic patients about their vision/sight on every clinic visit?	104 (67.1)	43 (27.7)	0 (0.0)	6 (3.9)	2 (1.3)
Do you do ophthalmoscopy routinely to your diabetic patients?.	36 (23.2)	61 (39.4)	4 (2.6)	32 (20.6)	22 (14.2)
Do you routinely send diabetics to ophthalmologists for an eye evaluation upon the first diagnosis of diabetes?	128 (82.6)	21 (13.5)	2 (1.3)	4 (2.6)	0 (0.0)
Do you do on follow up of your patients confirm if they have seen an eye doctor for their diabetes?	98 (63.2)	45 (29.0)	2 (1.3)	10 (6.5)	0 (0.0)
Do you advice for another eye checkup after a year if no retinopathy at initial examination?.	120 (77.4)	27 (17.4)	2 (1.3)	2 (1.3)	4 (2.6)
Do you advice for retinal evaluation every trimester for diabetic pregnant Patients?	56 (36.1)	55 (35.5)	22 (14.2)	10 (6.5)	12 (7.7)
Do you check the lipid profile of your diabetic patients regularly?	136 (87.7)	15 (9.7)	0 (0.0)	4 (2.6)	0 (0.0)
Do you check the Renal Function and blood pressure of your diabetic patients on regular basis?	132 (85.1)	19 (12.3)	0 (0.0)	4 (2.6)	0 (0.0)
Do you check for proteinuria regularly on your diabetic patients?	128 (82.6)	21 (13.5)	0 (0.0)	6 (3.9)	0 (0.0)
DM patients have periodic health education that includes eye affection of Diabetes in my clinic	96 (61.9)	43 (27.7)	0 (0.0)	8 (5.2)	8 (5.2)
	Always have	Sometimes have	Undecided	Used to have	Never have
Do you have an ophthalmoscope in your	74 (47.7)	37 (23.9)	0 (0.0)	20 (12.9)	24 (15.5)

clinic					
	Very confident	Confident	Undecided	Can try but not confident	Cannot do
Are you confident in doing retinal exam to detect DR using ophthalmoscope?	8 (5.2)	45 (29.0)	2 (1.3)	70 (45.1)	30 (19.4)

The practice of DR score ranged between 17 and 48 (out of a possible maximum of 48) with a mean of 38.7 and standard deviation (SD) of  $\pm 6.5$  and a median of 41 and IQR of 36-43 (Figure 6).



**Figure 6** Frequency distribution of the total practice related to diabetic retinopathy score among the participants.

#### Factors associated with practice related to diabetic retinopathy

Physicians who reported >40% of their seen patients were diabetics had the highest practice related to DR score (mean rank = 95) while those who reported <10% of their seen patients were diabetics had the lowest score (mean rank=58.82),  $p=0.044$  (Table 7).

**Table 7** Factors associated with practice related to diabetic retinopathy of primary healthcare physician's in Almadinah Almunawara.

	Diabetic retinopathy practice score			p-value
	Median	IQR	Mean rank	
Gender				
Male (n=77)	41	36-42.5	75.66	0.5171
Female (n=78)	41	36-43	80.31	
Specialty				
General practitioner (n=42)	39	33-43	70.15	0.438**
Family medicine (n=87)	42	37-43	84.0	
Internal medicine (n=16)	39.5	32-43	70.44	
Pediatrics (n=6)	39.5	31.25-44.5	76.08	
Others* (n=4)	37.5	31-43.25	63.0	
Percentage of seen diabetic patients				
<10% (n=14)				

10-20% (n=59)	38	30.25-42.25	59.82	0.044**
21-40% (n=56)	39	36-42	70.77	
>40% (n=26)	41	36-43.75	82.27	
	42.5	38-44.25	95.00	
Postgraduate qualification				0.297†
No (n=43)	39	33-43	71.95	
Yes (n=112)	41	36-43	80.32	
Years of practice				0.595**
<5 (n=52)	41	36-43	81.87	
5-15 (n=69)	41	36-43	78.14	
>15 (n=34)	39.5	32.75-43	71.81	
Special training in diabetes management				0.307†
No (n=99)	40	36-43	75.24	
Yes (n=56)	42	36-43	82.88	
Following any guideline for care of diabetes in practice				0.710†
No (n=3)	41	28-41	68.50	
Yes (n=152)	41	36-43	78.19	
The followed guideline (n=152)				0.330**
Saudi (n=46)	39.5	34.75-43	70.70	
ADA (n=70)	40.5	36-43	74.89	
Both (n=33)	42	38-43	85.56	
Both and ACE (n=3)	45	36-45	103.33	

\* Obstetrics and gynecology/Occupational medicine

† Mann-Whitney test

\*\* Kruskal-Wallis test

#### Correlation between knowledge, attitude and practice scores

As seen in Table 8, there were no significant correlations between knowledge about diabetic retinopathy, attitude towards diabetic retinopathy, and practice related to diabetic retinopathy scores.

**Table 8** Correlation between knowledge about diabetic retinopathy, attitude towards diabetic retinopathy, and practice related to diabetic retinopathy scores among primary healthcare physicians in Almadinah Almunawara.

	Knowledge	Practice
Attitude	r=0.038 p=0.638	r=-0.053 p=0.515
Practice	r=0.140 p=0.082	

#### 4. DISCUSSION

Diabetic retinopathy (DR) is one of the most frequent complications of diabetes mellitus and can result in blindness, if not early discovered and properly treated, especially at the level of primary healthcare (Al Rasheed et al., 2017). Therefore, the present study was carried out to assess the knowledge, attitude and practice of primary health care physician toward diabetic retinopathy in Almadinah, Kingdom of Saudi Arabia. The present study's results revealed that majority of the physicians working at primary healthcare centers had relatively short duration of practice (<15 years) and in accordance with a study carried out among general practitioners in Taif city, KSA (Al Ghamdi et al., 2017), almost one-third of the primary healthcare physicians in Al-Madinah had special training on diabetes management. Also, in agreement with results of Taif's study (Al Ghamdi et al., 2017), the majority of physicians following a guideline for care of diabetes in practice; however in the current study, the American Diabetic association

guidelines were the first followed and Saudi guidelines came second while in Taif's study (Al Ghamdi et al., 2017), Saudi guidelines ranked first and followed by the ADA. This difference could be attributed to the influence of educators of physicians in the two cities.

In the current study, fortunately, majority of primary healthcare physicians could recognize that a well-structured screening program at the primary health care level will reduce the visual impairment due to Diabetic retinopathy, early detection and management of DR play a critical role in the prevention of permanent visual loss and all diabetic patients should have a periodic retinal examination. Overall, the mean DR knowledge score was 11.1 of  $\pm 1.8$  out of a possible maximum of 14 which indicates acceptable level of knowledge. The same has been observed in studies carried out few years ago in Taif city, Saudi Arabia (Al Ghamdi et al., 2017), Oman (Khandekar et al., 2008), Nigeria (Abdulsalam et al., 2018) and Canada (Delorme et al., 1998).

In agreement with others (Al Rasheed & Adel et al., 2017), the present study observed that family physicians were more knowledgeable regarding DR compared to others. This may reflect the better quality of training offered to family medicine physicians during their residency training program compared to others. It is quite expected to find that postgraduate qualified physicians in the current study were more knowledgeable compared to their counterparts as regards DR. This is again reflects the role of postgraduate training in improving knowledge of the primary care physicians regarding DR. In accordance with Al Ghamdi et al., (2017), Physicians who reported having special training on diabetes management in the current study expressed better knowledge about DR than others. This finding emphasizes the positive role of special training in diabetes management in improving the knowledge of primary care physicians as regards DR.

Interestingly, the present study revealed that physicians who followed all guidelines (Saudi, ADA and AACE) expressed higher DR knowledge score than those followed only the Saudi guideline. Therefore, physicians should follow all possible guidelines regarding screening and management of DR in order to get more accurate information. In the present study, majority of the physicians disagreed that eye examination is required in diabetic patients only when vision is affected, newly detected diabetic patients do require an eye check-up, diabetic patients require an eye examination by ophthalmologist only at 5 yearly interval and primary physician or diabetologists have much role in the prevention and/or treatment of Diabetic retinopathy or not. However, positive attitude was expressed regarding the active involvement of GPs or diabetologists in doing retinal examination as part of Diabetic retinopathy screening program and in management of Diabetes mellitus. Also, majority of the primary healthcare physicians in the present study agreed regarding their need to have a re-training in eye examination for diabetic retinopathy. Therefore, retraining of primary healthcare physicians in ophthalmic examination of diabetic patients is highly needed. As quite expected, in the current study, physicians who have seen more diabetic patients expressed better attitude and practice related to DR than others.

In the present study, a weak not significant positive correlation was reported between knowledge about DR score and practice related to DR score. In the present study, 14.2% of primary healthcare physicians never do ophthalmoscopy routinely to their diabetic patients, only 47.7% of them always have an ophthalmoscope in their clinic and 45.1% can try doing retinal exam to detect DR using ophthalmoscope, but they are not confident. These findings indicate a relative defect in the practice of the primary healthcare physicians related to DR. The same gap between knowledge and practice in DR screening has been reported by others around the world, identified lack of ophthalmoscope and dilating drugs as the main barriers to do eye examination. In India, Raman et al., (2006) identified lack of good training of GPs about DR and how to detect it with direct ophthalmoscope, lack of dilating drops, and lack of knowledge of the guidelines among GPs as barriers for performing early screening for DR.

In the present survey, although physicians who had special training in diabetes management expressed better practice related to DR, it was not significant, which raises a concern regarding the quality and contents of such training activities. This study has some strengths including being the only one, up to our knowledge, in our Region to investigate such hot point of clinical significance as a result of high prevalence of DM, and inclusion of primary healthcare physicians as they are in front line in facing diabetic patients, so they are responsible for early screening and management of DR. Despite of that, some limitations should be addressed including the conduction of study among physicians working in primary healthcare centers, Ministry of health only ignoring those working in other disciplines, which could affect our aim to generalize the results over all primary care physicians. The cross-sectional design is considered another important limitation as it proves only association and not causality. Finally, barriers to practice proper screening and management of DR were not investigated in this study.

## 5. CONCLUSION AND RECOMMENDATIONS

Knowledge of physicians working at primary healthcare centers, Ministry of Health in Almadinah Almunawara regarding DR is overall accepted; Family physicians, those who had postgraduate qualification, who reported having special training on diabetes

management and physicians who followed all guidelines (Saudi, ADA and AACE) were more knowledgeable about DR compared to their counterparts. Also, their attitude towards diabetic retinopathy is acceptable. However, their practice-related to diabetic retinopathy is deficient in some important aspects.

Based on the study's findings, the following are recommended improve training of the primary healthcare physicians in DR screening skills using ophthalmoscopy during residency programs and afterwards through continuous medical education activities. Encourage primary care physicians to follow all the available guidelines (Saudi, ADA and AACE) for screening and managing cases of DR. Explore barriers for early DR screening and management by primary healthcare physicians in further study. Health authorities should offer proper infrastructure for early discover of DR through fundus eye examination in primary healthcare centers. Further larger longitudinal study included primary healthcare physicians from all disciplines in Almadinah Almunawara is recommended to have clearer image of the situation.

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### Informed consent

Informed consent was obtained from all participants included in the study.

### Author Contributions

All the authors contributed evenly with regards to data collecting, analysis, drafting and proofreading the final draft.

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### Conflict of Interest

The authors declare that there are no conflicts of interests.

### Data and materials availability

All data associated with this study are presented in the paper.

## REFERENCES AND NOTES

1. Abdulsalam S, Ibrahim A, Saidu H, Muazu M, Aliyu UT, Umar HI, Gezawa ID, Owolabi LF. Knowledge, attitude, and practice of diabetic retinopathy among physicians in Northwestern Nigeria. *Niger J Clin Pract* 2018; 21(4):478-483.
2. Ahmed RA, Khalil SN, Al-Qahtani MA. Diabetic retinopathy and the associated risk factors in diabetes type 2 patients in Abha, Saudi Arabia. *J Family Community Med* 2016; 23:18-24.
3. Al Dawish MA, Robert AA, Braham R, Al Hayek AA, Al Saeed A, Ahmed RA, Al Sabaan FS. Diabetes Mellitus in Saudi Arabia: A Review of the Recent Literature. *Curr Diabetes Rev* 2016; 12(4):359-368.
4. Al Ghamdi A, Rabiou M, Al Qurashi AM, Al Zaydi M, Al Ghamdi AH, Gumaa SA, Althomali TA. Knowledge, attitude and practice pattern among general health practitioners regarding diabetic retinopathy Taif, Kingdom of Saudi Arabia. *Saudi J Health Sci* 2017; 6(1): 44-51.
5. Al Ghamdi AH, Rabiou M, Hajar S, Yorston D, Kuper H, Polack S. Rapid assessment of avoidable blindness and diabetic retinopathy in Taif, Saudi Arabia. *Br J Ophthalmol* 2012; 96:1168-72.
6. Al Rasheed R, Al Adel F. Diabetic retinopathy: Knowledge, awareness and practices of physicians in primary-care centers in Riyadh, Saudi Arabia. *Saudi J Ophthalmol* 2017; 31(1): 2-6.
7. Alhawaish AK. Economic costs of diabetes in Saudi Arabia. *J Family Community Med* 2013; 20:1-7.
8. Bahijri SM, Jambi HA, Al Raddadi RM, Ferns G, Tuomilehto J. The prevalence of diabetes and prediabetes in the adult



- population of Jeddah, Saudi Arabia – A community-based survey. *PLoS One* 2016; 11:e0152559.
9. Delorme C, Boisjoly HM, Baillargeon L, Turcotte P, Bernard PM. Screening for diabetic retinopathy. Do family physicians know the Canadian guidelines?" *Can Fam Physician*. 1998; 44:1473-9.
10. El-Asrar AM, Al-Rubeaan KA, Al-Amro SA, Kangave D, Moharram OA. Risk factors for diabetic retinopathy among Saudi diabetics. *Int Ophthalmol* 1999; 22:155-61.
11. El-Bab MF, Shawky N, Al-Sisi A, Akhtar M. Retinopathy and risk factors in diabetic patients from Al-Madinah Al-Munawarah in the Kingdom of Saudi Arabia. *Clin Ophthalmol* 2012; 6:269-76.
12. Elhadd TA, Al-Amoudi AA, Alzahrani AS. Epidemiology, clinical and complications profile of diabetes in Saudi Arabia: A review. *Ann Saudi Med* 2007; 27:241-50.
13. Hajar S, Al Hazmi A, Wasli M, Mousa A, Rabiou M. Prevalence and causes of blindness and diabetic retinopathy in Southern Saudi Arabia. *Saudi Med J* 2015; 36:449-55.
14. IDF Diabetes Atlas Group. Update of mortality attributable to diabetes for the IDF Diabetes Atlas: Estimates for the year 2013. *Diabetes Res Clin Pract* 2015; 109:461-5.
15. Khan AR, Wiseberg JA, Lateef ZA, Khan SA. Prevalence and determinants of diabetic retinopathy in Al Hasa region of Saudi Arabia: Primary health care centre based cross-sectional survey, 2007-2009. *Middle East Afr J Ophthalmol* 2010; 17:257-63.
16. Khandekar R, Shah S, Al Lawatti J. Retinal examination of diabetic patients: knowledge, attitudes and practices of physicians in Oman. *East Mediterr* 2008; 14(4):850-7.
17. Khandekar R. Screening and public health strategies for diabetic retinopathy in the Eastern Mediterranean region. *Middle East Afr J Ophthalmol* 2012; 19:178-84.
18. Nentwich MM, Ulbig MW. Diabetic retinopathy-ocular complications of diabetes mellitus. *World J Diabetes* 201; 6(3): 489-499.
19. Raman R, Paul PG, Padmajakumari R, Sharma T. Knowledge and attitude of general practitioners towards diabetic retinopathy practice in South India. *Community Eye Health* 2006; 19(57):13-4.
20. Raman R, Rani PK, Reddi Rachepalle S, Gnanamoorthy P, Uthra S, Kumaramanickavel G, Sharma T. Prevalence of diabetic retinopathy in India: Sankara Nethralaya Diabetic Retinopathy Epidemiology and Molecular Genetics Study report 2. *Ophthalmology* 2009; 116(2):311-8.
21. Robert AA, Al Dawish MA, Braham R, Musallam MA, Al Hayek AA, AlKahtany NH. Type 2 diabetes mellitus in Saudi Arabia: Major challenges and possible solutions. *Curr Diabetes Rev* 2017; 13(1):59-64.
22. Shay JW, Homma N, Zhou R, Naseer MI, Chaudhary AG, Al-Qahtani M, Abstr Shay JW, Homma N, Zhou R, Naseer MI, Chaudhary AG, Al-Qahtani M, Hirokawa N, Goudarzi M, Fornace AJ Jr, Baeesa S, Hussain D, Bangash M, Alghamdi F, Schulten HJ, Carracedo A, Khan I, Qashqari H, Madkhali N, Saka M, Saini KS, Jamal A, Al-Maghrabi J, Abuzenadah A, Chaudhary A, Al Qahtani M, Damanhour G, Alkhatabi H, Goodeve A, Crookes L, Niksic N, Beauchamp N, Abuzenadah AM, Vaught J, Budowle B, Assidi M, Buhmeida A, Al-Maghrabi J, Buhmeida A, Assidi M, Merdad L, Kumar S, Miura S, Gomez K, Carracedo A, Rasool M, Rebai A, Karim S, Eldin HFN, Abusamra H, Alhathli EM, Salem N, Al-Qahtani MH, Kumar S, Faheem H, Agarwa A, Nieschlag E, Wistuba J, Damm OS, Beg MA, Abdel-Meguid TA, Mosli HA, Bajouh OS, Abuzenadah AM, Al-Qahtani MH, Coskun S, Abu-Elmagd M, Buhmeida A, Dallol A, Al-Maghrabi J, Hakamy S, Al-Qahtani W, Al-Harbi A, Hussain S, Assidi M, Al-Qahtani M, Abuzenadah A, Ozkosem B, DuBois R, Messaoudi SS, Dandana MT, Mahjoub T, Almawi WY, Abdalla S, Al-Aama MN, Elzawahry A, Takahashi T, Mimaki S, Furukawa E, Nakatsuka R, Kurosaka I, Nishigaki T, Nakamura H, Serada S, Naka T, Hirota S, Shibata T, Tsuchihara K, Nishida T, Kato M, Mehmood S, Ashraf NM, Asif A, Bilal M, Mehmood MS, Hussain A, Jamal QMS, Siddiqui MU, Alzohairy MA, Al Karaawi MA, Nedjadi T, Al-Maghrabi J, Assidi M, Al-Khattabi H, Al-Ammari A, Al-Sayyad A, Buhmeida A, Al-Qahtani M, Zitouni H, Raguema N, Ali MB, Malah W, Lfalah R, Almawi W, Mahjoub T, Elanbari M, Ptitsyn A, Mahjoub S, El Ghali R, Achour B, Amor NB, Assidi M, N'siri B, Morjani H, Nedjadi T, Al-Ammari A, Al-Sayyad A, Salem N, Azhar E, Al-Maghrabi J, Chayeb V, Dendena M, Zitouni H, Zouari-Limayem K, Mahjoub T, Refaat B, Ashshi AM, Batwa SA, Ramadan H, Awad A, Ateya A, El-Shemi AGA, Ashshi A, Basalamah M, Na Y, Yun CO, El-Shemi AGA, Ashshi A, Basalamah M, Na Y, Yun CO, El-Shemi AG, Refaat B, Kensara O, Abdelfattah A, Dheeb BI, Al-Halbosi MMF, Al lihabi RK, Khashman BM, Laiche D, Adeel C, Taoufik N, Al-Afghani H, Lastowska M, Al-Balool HH, Sheth H, Mercer E, Coxhead JM, Redfern CPF, Peters H, Burt AD, Santibanez-Koref M, Bacon CM, Chesler L, Rust AG, Adams DJ, Williamson D, Clifford SC, Jackson MS, Singh M, Mansuri MS, Jadeja SD, Patel H, Marfatia YS, Begum R, Mohamed AM, Kamel AK, Helmy NA, Hammad SA, Kayed HF, Shehab MI, El Gerzawy A, Ead MM, Ead OM, Mekki M, Mazen I, El-Ruby M, Shahid SMA, Jamal QMS, Arif JM, Lohani M, Imen M, Leila C, Houyem O, Kais D, Fethi CDM, Mohamed B, Salem A, Faggad A, Gebreslasie AT, Zaki HY, Abdalla BE, AlShammari MS, Al-Ali R, Al-Balawi N, Al-Enazi M, Al-Muraikhi A, Busaleh F, Al-Sahwan A, Borgio F, Sayyed A, Al-Ali A, Acharya S, Zaki MS, El-Bassayouni HT, Shehab MI, Elshal MF, M. K, Aldahlawi AM, Saadah O, McCoy JP, El-

Tarras AE, Awad NS, Alharthi AA, Ibrahim MMM, Alsehli HS, Dallol A, Gari AM, Abbas MM, Kadam RA, Gari MM, Alkaff MH, Abuzenadah AM, Gari MA, Abusamra H, Karim S, eldin HFN, Alhathli EM, Salem N, Kumar S, Al-Qahtani MH, Moradi FA, Rashidi OM, Awan ZA, Kaya IH, Al-Harazi O, Colak D, Alkousi NA, Athanasopoulos T, Bahmaid AO, Alhwait EA, Gari MA, Alsehli HS, Abbas MM, Alkaf MH, Kadam R, Dallol A, Kalamegam G, Eldin HFN, Karim S, Abusamra H, Alhathli E, Salem N, Al-Qahtani MH, Kumar S, Alsayed SN, Aljohani FH, Habeeb SM, Almashali RA, Basit S, Ahmed SM, Sharma R, Agarwal A, Durairajanayagam D, Samanta L, Abu-Elmagd M, Abuzenadah AM, Sabanegh ES, Assidi M, Al-Qahtani M, Agarwal A, Sharma R, Samanta L, Durairajanayagam D, Assidi M, Abu-Elmagd M, Al-Qahtani M, Abuzenadah AM, Sabanegh ES, Samanta L, Agarwal A, Sharma R, Cui Z, Assidi M, Abuzenadah AM, Abu-Elmagd M, Al-Qahtani M, Alboogmi AA, Alansari NA, Al-Quaiti MM, Ashgan FT, Bandah A, Jamal HS, Rozi A, Mirza Z, Abuzenadah AM, Karim S, Al-Qahtani MH, Karim S, Schulten HJ, Al Sayyad AJ, Farsi HMA, Al-Maghrabi JA, Mirza Z, Alotibi R, Al-Ahmadi A, Alansari NA, Albogmi AA, Al-Quaiti MM, Ashgan FT, Bandah A, Al-Qahtani MH, Ebiya RA, Darwish SM, Montaser MM, Abusamra H, Bajic VB, Al-Maghrabi J, Gomaa W, Hanbazazh M, Al-Ahwal M, Al-Harbi A, Al-Qahtani W, Hakamy S, Baba G, Buhmeida A, Al-Qahtani M, Al-Maghrabi J, Al-Harbi A, Al-Ahwal M, Al-Harbi A, Al-Qahtani W, Hakamy S, Baba G, Buhmeida A, Al-Qahtani M, Alhathli EM, Karim S, Salem N, Eldin HN, Abusamra H, Kumar S, Al-Qahtani MH, Alyamani AA, Kalamegam G, Alhwait EA, Gari MA, Abbas MM, Alkaf MH, Alsehli HS, Kadam RA, Al-Qahtani M, Gadi R, Buhmeida A, Assidi M, Chaudhary A, Merdad L, Alfakheh SM, Alhwait EA, Gari MA, Abbas MM, Alkaf MH, Alsehli HS, Kadam R, Kalamegam G, Ghazala R, Mathew S, Hamed MH, Assidi M, Al-Qahtani M, Qadri I, Mathew S, Mira L, Shaabad M, Hussain S, Assidi M, Abu-Elmagd M, Al-Qahtani M, Mathew S, Shaabad M, Mira L, Hussain S, Assidi M, Abu-Elmagd M, Al-Qahtani M, Rebai A, Assidi M, Buhmeida A, Abu-Elmagd M, Dallol A, Shay JW, Almutairi MH, Ambers A, Churchill J, King J, Stoljarova M, Gill-King H, Assidi M, Abu-Elmagd M, Buhmeida A, Al-Qatani M, Budowle B, Abu-Elmagd M, Ahmed F, Dallol A, Assidi M, Almagd TA, Hakamy S, Agarwal A, Al-Qahtani M, Abuzenadah A, Karim S, Schulten HJ, Al Sayyad AJ, Farsi HMA, Al-Maghrabi JA, Buhmeida A, Mirza Z, Alotibi R, Al-Ahmadi A, Alansari NA, Albogmi AA, Al-Quaiti MM, Ashgan FT, Bandah A, Al-Qahtani MH, Satar R, Rasool M, Ahmad W, Nazam N, Lone MI, Naseer MI, Jamal MS, Zaidi SK, Pushparaj PN, Jafri MA, Ansari SA, Alqahtani MH, Bashier H, Al Qahtani A, Mathew S, Nour AM, Alkhatabi H,

Zenadah AMA, Buhmeida A, Assidi M, Al Qahtani M, Faheem M, Mathew S, Mathew S, Pushparaj PN, Al-Qahtani MH, Alhadrami HA, Dallol A, Abuzenadah A, Hussein IR, Chaudhary AG, Bader RS, Bassiouni R, Alquaiti M, Ashgan F, Schulten H, Alama MN, Al Qahtani MH, Lone MI, Nizam N, Ahmad W, Jafri MA, Rasool M, Ansari SA, Al-Qahtani MH, Alshihri E, Abu-Elmagd M, Alharbi L, Assidi M, Al-Qahtani M, Mathew S, Natesan PP, Al Qahtani M, Kalamegam G, Pushparaj PN, Khan F, Kadam R, Ahmed F, Assidi M, Sait KHW, Anfinan N, Al Qahtani M, Naseer MI, Chaudhary AG, Jamal MS, Mathew S, Mira LS, Pushparaj PN, Ansari SA, Rasool M, AlQahtani MH, Naseer MI, Chaudhary AG, Mathew S, Mira LS, Jamal MS, Sogaty S, Bassiouni RI, Rasool M, AlQahtani MH, Rasool M, Ansari SA, Jamal MS, Pushparaj PN, Sibiani AMS, Ahmad W, Buhmeida A, Jafri MA, Warsi MK, Naseer MI, Al-Qahtani MH, Rubi, Kumar K, Naqvi AAT, Ahmad F, Hassan MI, Jamal MS, Rasool M, AlQahtani MH, Ali A, Jarullah J, Rasool M, Buhmeida A, Khan S, Abdussami G, Mahfooz M, Kamal MA, Damanhour GA, Jamal MS, Jarullah B, Jarullah J, Jarullah MSS, Ali A, Rasool M, Jamal MS, Assidi M, Abu-Elmagd M, Bajouh O, Pushparaj PN, Al-Qahtani M, Abuzenadah A, Jamal MS, Jarullah J, Mathkooor AEA, Alsalmi HMA, Oun AMM, Damanhauri GA, Rasool M, AlQahtani MH, Naseer MI, Rasool M, Sogaty S, Chudhary AG, Abutalib YA, Merico D, Walker S, Marshall CR, Zarrei M, Scherer SW, Al-Qahtani MH, Naseer MI, Faheem M, Chaudhary AG, Rasool M, Kalamegam G, Ashgan FT, Assidi M, Ahmed F, Zaidi SK, Jan MM, Al-Qahtani MH, Al-Zahrani M, Lary S, Hakamy S, Dallol A, Al-Ahwal M, Al-Maghrabi J, Dermitzakis E, Abuzenadah A, Buhmeida A, Al-Qahtani M, Al-refai AA, Saleh M, Yassien RI, Kamel M, Habeb RM, Filimban N, Dallol A, Ghannam N, Al-Qahtani M, Abuzenadah AM, Bibi F, Akhtar S, Azhar EI, Yasir M, Nasser MI, Jiman-Fatani AA, Sawan A, Lahzah RA, Ali A, Hassan SA, Hasnain SE, Tayubi IA, Abujabal HA, Magrabi AO, Khan F, Kalamegam G, Pushparaj PN, Abuzenada A, Kumosani TA, Barbour E, Al-Qahtani M, Shabaad M, Mathew S, Dallol A, Merdad A, Buhmeida A, Al-Qahtani M, Assidi M, Abu-Elmagd M, Gauthaman K, Gari M, Chaudhary A, Abuzenadah A, Pushparaj PN, Al-Qahtani M, Hassan SA, Tayubi IA, Aljahdali HMA, Al Nono R, Gari M, Alsehli H, Ahmed F, Abbas M, Kalamegam G, Al-Qahtani M, Mathew S, Khan F, Rasool M, Jamal MS, Naseer MI, Mirza Z, Karim S, Ansari S, Assidi M, Kalamegam G, Gari M, Chaudhary A, Abuzenadah A, Pushparaj PN, Al-Qahtani M, Abu-Elmagd M, Kalamegam G, Kadam R, Alghamdi MA, Shamy M, Costa M, Khoder MI, Assidi M, Pushparaj PN, Gari M, Al-Qahtani M, Kharrat N, Belmabrouk S, Abdelhedi R, Benmarzoug R, Assidi M, Al Qahtani MH, Rebai A, Dhamanhour G, Pushparaj PN,

- Noorwali A, Alwasiyah MK, Bahamaid A, Alfakeeh S, Alyamani A, Alsehli H, Abbas M, Gari M, Mobasher A, Kalamegam G, Al-Qahtani M, Faheem M, Mathew S, Pushparaj PN, Al-Qahtani MH, Mathew S, Faheem M, Mathew S, Pushparaj PN, Al-Qahtani MH, Jamal MS, Zaidi SK, Khan R, Bhatia K, Al-Qahtani MH, Ahmad S, AslamTayubi I, Tripathi M, Hassan SA, Shrivastava R, Tayubi IA, Hassan S, Abujabal HAS, Shah I, Jarullah B, Jamal MS, Jarullah J, Sheikh IA, Ahmad E, Jamal MS, Rehan M, Abu-Elmagd M, Tayubi IA, AlBasri SF, Bajouh OS, Turki RF, Abuzenadah AM, Damanhour GA, Beg MA, Al-Qahtani M, Hammoudah SAF, AlHarbi KM, El-Attar LM, Darwish AMZ, Ibrahim SM, Dallol A, Choudhry H, Abuzenadah A, Awlia J, Chaudhary A, Ahmed F, Al-Qahtani M, Jafri MA, Abu-Elmagd M, Assidi M, Al-Qahtani M, Khan I, Yasir M, Azhar EI, Al-basri S, Barbour E, Kumosani T, Khan F, Kalamegam G, Pushparaj PN, Abuzenada A, Kumosani TA, Barbour E, EL Sayed HM, Hafez EA, Schulten HJ, Elaimi AH, Hussein IR, Bassiouni RI, Alwasiyah MK, Wintle RF, Chaudhary A, Scherer SW, Al-Qahtani M, Mirza Z, Pillai VG, Karim S, Sharma S, Kaur P, Srinivasan A, Singh TP, Al-Qahtani M, Alotibi R, Al-Ahmadi A, Al-Adwani F, Hussein D, Karim S, Al-Sharif M, Jamal A, Al-Ghamdi F, Al-Maghrabi J, Baesa SS, Bangash M, Chaudhary A, Schulten HJ, Al-Qahtani M, Faheem M, Pushparaj PN, Mathew S, Kumosani TA, Kalamegam G, Al-Qahtani M, Al-Allaf FA, Abduljaleel Z, Alashwal A, Taher MM, Bouazzaoui A, Abalkhail H, Ba-Hammam FA, Athar M, Kalamegam G, Pushparaj PN, Abu-Elmagd M, Ahmed F, Sait KH, Anfinan N, Gari M, Chaudhary A, Abuzenadah A, Assidi M, Al-Qahtani M, Mami NB, Haffani YZ, Medhioub M, Hamzaoui L, Cherif A, Azouz M, Kalamegam G, Khan F, Mathew S, Nasser MI, Rasool M, Ahmed F, Pushparaj PN, Al-Qahtani M, Turkistany SA, Al-harbi LM, Dallol A, Sabir J, Chaudhary A, Abuzenadah A, Al-Madoudi B, Al-Aslani B, Al-Harbi K, Al-Jahdali R, Qudaih H, Al Hamzy E, Assidi M, Al Qahtani M, Ilyas AM, Ahmed Y, Gari M, Ahmed F, Alqahtani M, Salem N, Karim S, Alhathli EM, Abusamra H, Eldin HFN, Al-Qahtani MH, Kumar S, Al-Adwani F, Hussein D, Al-Sharif M, Jamal A, Al-Ghamdi F, Al-Maghrabi J, Baesa SS, Bangash M, Chaudhary A, Al-Qahtani M, Schulten HJ, Alamandi A, Alotibi R, Hussein D, Karim S, Al-Maghrabi J, Al-Ghamdi F, Jamal A, Baesa SS, Bangash M, Chaudhary A, Schulten HJ, Al-Qahtani M, Subhi O, Bagatian N, Karim S, Al-Johari A, Al-Hamour OA, Al-Aradati H, Al-Mutawa A, Al-Mashat F, Al-Maghrabi J, Schulten HJ, Al-Qahtani M, Bagatian N, Subhi O, Karim S, Al-Johari A, Al-Hamour OA, Al-Mutawa A, Al-Aradati H, Al-Mashat F, Al-Qahtani M, Schulten HJ, Al-Maghrabi J, Shah MW, Yasir M, Azhar EI, Al-Masoodi S, Haffani YZ, Azouz M, Khamla E, Jlassi C, Masmoudi AS, Cherif A, Belbahri L, Al-Khayyat S, Attas R, Abu-Sanad A, Abuzinadah M, Merdad A, Dallol A, Chaudhary A, Al-Qahtani M, Abuzenadah A, Bouazzi H, Trujillo C, Alwasiyah MK, Al-Qahtani M, Alotaibi M, Nassir R, Sheikh IA, Kamal MA, Jiffri EH, Ashraf GM, Beg MA, Aziz MA, Ali R, Rasool M, Jamal MS, Samman N, Abdussami G, Periyasamy S, Warsi MK, Aldress M, Al Otaibi M, Al Yousef Z, Boudjelal M, Buhmeida A, Al-Qahtani MH, AlAbdulkarim I, Ghazala R, Mathew S, Hamed MH, Assidi M, Al-Qahtani M, Qadri I, Sheikh IA, Abu-Elmagd M, Turki RF, Damanhour GA, Beg MA, Suhail M, Qureshi A, Jamal A, Pushparaj PN, Al-Qahtani M, Qadri I, El-Readi MZ, Eid SY, Wink M, Isa AM, Alnuaim L, Almutawa J, Abu-Rafae B, Alasiri S, Binsaleh S, Nazam N, Lone MI, Ahmad W, Ansari SA, Alqahtani MH. Abstracts from the 3rd International Genomic Medicine Conference (3rd IGM 2015): Jeddah, Kingdom of Saudi Arabia. 30 November - 3 December 2015. BMC Genomics. 2016; 17 Suppl 6(Suppl 6):487.
23. Sparrow JM, McLeod BK, Smith TD, Birch MK, Rosenthal AR. The prevalence of diabetic retinopathy and maculopathy and their risk factors in the non-insulin-treated diabetic patients of an English town. *Eye (Lond)* 1993; 7(Pt 1):158-63.
  24. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. *Diabetes Care* 2004; 27:1047-53.
  25. Zhang X, Saaddine JB, Chou CF, Cotch MF, Cheng YJ, Geiss LS, et al. Prevalence of diabetic retinopathy in the United States, 2005-2008. *JAMA* 2010; 304:649-56